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HEATED CERAMIC SUBSTRATE SUPPORT
WITH PROTECTIVE COATING

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HEATED CERAMIC SUBSTRATE SUPPORT WITH PROTECTIVE COATING

Background

5   The present invention relates to a substrate support for holding a substrate in a substrate processing chamber.

In the fabrication of electronic circuits and displays, semiconductor, dielectric, and electrically conducting materials are formed on a substrate, such as a
10   silicon wafer or glass. The materials are typically formed by chemical vapor deposition (CVD), physical vapor deposition (PVD), ion implantation, oxidation and nitridation processes. Thereafter, the materials are etched to form features such as gates, vias, contact holes and interconnect lines. In a typical deposition or etching process, the substrate is exposed to a plasma to deposit or etch, respectively, a layer of material on
15   the substrate. The plasma is can be formed by inductively or capacitively coupling energy to a process gas or by passing microwaves through the process gas.

The substrate fabrication processes are typically carried out in a substrate processing apparatus comprising one or more process chambers. A typical process
20   chamber comprises a substrate support having a substrate receiving surface to hold the substrate in a process zone. The substrate support is exposed to a plasma formed in the chamber. The plasma can have elevated temperatures that arise from the interaction of energetic gaseous plasma species with one another and with the support. The substrate support can also be heated to maintain the substrate at elevated
25   processing temperatures. Thus, the substrate support should be able to withstand exposure to the high process temperatures. For this reason, substrate supports often comprise ceramic materials, such as aluminum oxide (Al_2O_3) or aluminum nitride (AlN). Ceramic materials are able to withstand high temperatures without melting or otherwise degrading.
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However, certain ceramic substrate supports are susceptible to corrosion by the particular compositions of gases used to generate the plasma in the chamber. For example, a ceramic substrate support of aluminum nitride corrodes in halogen gases to form undesirable gaseous byproducts, such as $AlCl_3$ or AlF_3, which

subsequently condense on the walls and surfaces in the chamber. These deposited byproducts accumulate on the internal chamber surfaces over multiple process cycles in the course of processing a batch of substrates, until they get too thick, flake off and fall on the substrate or contaminate the chamber itself. The flaked off deposits reduce

5   the yields of the circuits, displays or other devices manufactured on the substrate. Accumulated deposits also necessitate frequent cleaning of the chamber walls and resultant chamber downtime, thereby increasing equipment capitalization costs.

Corrosion of the ceramic substrate support is further exacerbated when

10   the support is heated by an underlying heating system to maintain specified substrate temperatures. The substrate can be maintained at a high temperature to promote a localized heating environment that is desirable for the process being conducted. For example, particular substrate temperatures may be maintained to promote preferential decomposition of plasma species to deposit a layer on the substrate in a CVD process

15   or to etch the substrate in an etching process. The elevated temperatures of the substrate support can exacerbate corrosion of the ceramic support because corrosion reactions are typically faster at higher temperatures. Also, corners or curved surfaces on the substrate support may be even more susceptible to corrosion.

20   Thus, there is a need for a substrate support that is capable of withstanding elevated temperatures. There is also a need for a substrate support that does not generate corrosion byproducts in erosive gas environments that could deposit on the enclosing walls of, and contaminate, the process chamber.

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Summary

A substrate support comprises (i) a ceramic block having a substrate receiving pocket that is sized to receive a substrate therein, a peripheral ledge extending about the substrate pocket, and side surfaces; (ii) a ceramic coating comprising an amorphous Si-H-N-O compound, the coating covering the substrate pocket and peripheral ledge of the ceramic block; (iii) a resistance heater in the ceramic block; and (iv) heater leads extending out of the ceramic block to conduct electrical power to the resistance heater.

Also provided is a method of refurbishing a substrate support having a ceramic block and a residual ceramic coating. The refurbishment method comprises exposing the ceramic block to a fluorine-containing medium to remove the residual ceramic coating from the block to form a clean ceramic block, placing the clean ceramic block in a deposition chamber, and depositing a new ceramic coating on at least a portion of the clean ceramic block.

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Drawings

These features, aspects, and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawings which illustrate exemplary features of the invention:

Figure 1a is a sectional side view of an embodiment of a substrate support according to the present invention;

Figure 1b is a schematic sectional view of the support shown in Figure 1a along section A-A;

Figure 1c is another schematic sectional view of the support shown in Figure 1a along section B-B;

Figure 1d is yet another schematic sectional view of the support shown in Figure 1a along section C-C;

Figure 2a is a schematic sectional side view of another embodiment of the support showing an alternative coating coverage;

Figure 2b is a schematic sectional side view of yet another embodiment of the support showing an alternative coating coverage; and

Figure 3 is a schematic sectional side view of an embodiment of a substrate processing chamber comprising the substrate support.

Description

A substrate support is capable of holding a substrate in a substrate processing chamber. An embodiment of the substrate support **20** is schematically illustrated in Figures 1a-c. Generally, the substrate support **20** comprises a ceramic block **28** having a top surface **22** that is exposed to the plasma in the chamber. The ceramic block **28** is a monolith comprising a unitary structure composed of a dielectric or semiconducting ceramic material. The top surface **22** of the ceramic block **28** comprises a substrate receiving pocket **24** into which a substrate **21** is received for processing. The pocket **24** is planar and recessed relative to other portions of the top surface **22** of the ceramic block **28**. The pocket **24** is sized to receive and accurately position the substrate **21** on the receiving surface **22**. The ceramic block **28** also comprises a peripheral ledge **23** extending about the substrate receiving pocket **24**. The peripheral ledge **23** serves to hold the substrate in place, and also protect the bottom and side surfaces **25** of the substrate from unwanted deposition. In one version, the peripheral ledge **23** has a height of about 6% to about 8% of the height of a typical substrate **21**; however, other suitable heights may also be used. The transition **27** between the pocket **24** and the peripheral ledge **23** comprises a chamfered corner. The arcuate corner further reduces the erosion susceptibility of the dielectric material in corrosive gas environments.

Corrosive gases present in a substrate processing chamber, such as a halogen based plasma, can corrode the ceramic block **28**. In general, the exposed surfaces of the entire ceramic block **28**, which include the top surface **22** and a side surface **29**, are subject to corrosion. In particular, the transition region **27** between the substrate pocket **24** and the peripheral ledge **23** is especially susceptible to corrosion because it has a non-planar geometry. Corrosion occurs because energized gas used to process the substrate or clean the chamber can etch the ceramic block **28**. For example, an energized halogen gas, such as a chlorine-containing gas used to clean certain types of chambers is capable of etching many ceramics, including aluminum nitride. Etching byproducts can be generated as deposits on chamber walls or particles within the chamber. These deposits can eventually peel and flake off the walls to generate particles that can fall into a substrate **21** and reduce the yield of devices or circuits being manufactured on the substrate **21**.

To reduce or eliminate this problem, the ceramic block **28** of the substrate support **20** further comprises a ceramic coating **40** on at least the plasma exposed portions of the top surface **22** of the ceramic block **28**. The protective ceramic coating

5 **40** is made of a different ceramic material than the ceramic block **28**. Thus, if the ceramic block **28** is composed of a first ceramic material, the ceramic coating **40** is composed of a second ceramic material. In one version, as illustrated in Figure 1a, the ceramic coating **40** extends substantially across the entire top surface **22**, including the recessed substrate pocket **24**, peripheral ledge **23**, and transition region **27**. This

10 version is useful when only the top surface **22** is exposed to a corrosive gas, for example, when there are rings or liners that effectively separate the process zone from other surfaces of the substrate support **20,** such as side surfaces **29** and a bottom surface **31**. In this version, it is not necessary for the coating coverage to include portions of the ceramic block **28** other than the substrate receiving surface **22**.

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In other versions, illustrated in Figures 2a-b, the coating **40** covers the entire ceramic block **28** or selective portions of the block **28**. For example, in Figure 2a, the coating coverage includes the entire external surfaces of the ceramic block **28**. This version is useful when the entire substrate support **20** is subjected to corrosive

20 gases, for example, when the substrate support **20** is positioned in a chamber such that the side **29** and bottom surfaces **31** of the ceramic block **28** are exposed to the process zone. The coating covers all exposed areas of the ceramic block **28**.

In Figure 2b, the coating coverage includes the top surface **22** and the

25 sides **29** of the ceramic block. This version is useful when the top surface **22** and the sides **29** of the ceramic block are exposed to corrosive gases, but other surfaces of the ceramic block are not. For example, this could occur if the bottom surface **31** of the ceramic block is covered by another surface within the chamber, for instance a support member below the substrate support **20**, or a surface of an enclosing wall of the

30 chamber.

The portions of the block **28** covered by the coating **40** are selected depending on the application of the substrate support **20** and the method used to manufacture the substrate support **20**. Thus, while particular exemplary embodiments

of coating coverage are illustrated herein, other coating coverage embodiments are possible for different applications as would be evident to one of ordinary skill in the art, so the illustrative embodiments should not be used to limit the scope of the invention.

5   The coating **40** is composed of a material that is selected so that even though the material is eroded by the corrosive process gas, the erosion byproducts of the coating **40** are volatile products that do not condense on the chamber surfaces to form deposits on the chamber walls or gas phase nucleated particles within the chamber. The coating **40** essentially transforms from the solid phase to a volatile gas

10   phase, which is then exhausted by the vacuum pumps of the chamber. This solves the problem of contaminating deposits and particles because the coating **40** does not contribute condensable species that form deposits and particles in the chamber. For example, when the coating **40** comprises silicon nitride, the byproducts of silicon nitride eroded by a corrosive energized chlorine gas atmosphere are exhausted through a gas

15   outlet of the chamber and do not remain as deposits or particles in the chamber. Thus, the coating performs as a sacrificial layer that protects the underlying ceramic material from the erosive gaseous environment.

          In one version, the ceramic block **28** comprises a ceramic material with a

20   volume electrical resistivity of greater than about 10^{14} ohm·cm at 20°C. The dielectric material is also selected to have a good thermal conductivity to facilitate heat transfer between the support and the substrate. The thermal conductivity of the ceramic material should be such that the rate of heat transferred through the block to the substrate achieves a desired level. For example, the ceramic can comprise a thermal

25   conductivity of from about 140 W/m·K to about 180 W/m·K. In one version, the block **28** comprises a ceramic such as aluminum nitride. The block **28** can comprise, for example, at least about 99.9% aluminum nitride by weight.

          In one version, a suitable ceramic coating **40** comprises a silicon nitride

30   compound. The coating **40** can comprise, for example, at least about 90% silicon nitride by weight. The coating **40** protects the underlying ceramic block **28** from being eroded by corrosive gases and plasma present in the chamber. The coating is composed of a second material that is a different ceramic material than the ceramic material of the underlying ceramic block **28**. For example, when the first ceramic

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material is AlN, and the corrosive process gas includes Cl_2, the second material may comprise Si_3N_4.

In another version, the coating **40** comprises a ceramic material comprising at least about 50% of a silicon nitride compound by weight. One advantage to this version is that the response of the coating **40** can be tailored to protect the block from different corrosive gases. For example, if the corrosive gas comprises NF_3, ClF_3 and HCl, then the coating **40** could have a composition of about 75% by weight of the silicon nitride compound, with the remaining 25% of silicon dioxide. This would provide suitable corrosion response of the coating **40** to Cl_2, NF_3, ClF_3, and C_2F_6.

In yet another version, the coating **40** comprises an amorphous ceramic compound. In one embodiment of this version, the amorphous ceramic compound comprises silicon, nitrogen, hydrogen, and oxygen. The advantage of an amorphous Si-N-H-O compound is that the composition of the coating **40** can be selected to provide suitable protection for the block **28** against various corrosive gases. Another advantage of an amorphous Si-N-H-O compound is that that composition of the coating **40** can be selected to provide suitable adherence of the coating **40** to various ceramic block materials. In this embodiment, the silicon content of the amorphous compound can be from about 30% to about 50% by weight. The nitrogen content can be from about 20% to about 40% by weight. The hydrogen content can be from about 2% to about 30% by weight. The oxygen content can be from about 1% to about 5% by weight. In another embodiment of this version, the amorphous ceramic compound comprises a silicon nitride compound.

The ceramic coating **40** comprising a silicon nitride compound or an amorphous Si-H-N-O compound also provides a good thermal expansion coefficient match with a ceramic block **28** comprising aluminum nitride. A suitable silicon nitride or amorphous Si-H-N-O compound can have a thermal expansion coefficient of, for example, from about 3.1×10^{-6} /°C to about 3.4×10^{-6} /°C at room temperature. By comparison, the aluminum nitride material has a thermal expansion coefficient of, for example, about 4.4×10^{-6} /°C to about 4.7×10^{-6} /°C at room temperature. An excessively large mismatch in thermal expansion coefficients is undesirable because the substrate support **20** potentially goes through temperature cycles that cause

stresses in the coating **40** as the support **20** expands and contracts. These stresses can eventually cause the coating **40** to crack and peel away from the ceramic block **28**, which it is desirable to avoid.

5   The thickness of the coating **40** is selected to withstand multiple process cycles while providing good thermal performance. The thickness varies depending on the choice of the ceramic block material and the manufacturing methods used to produce the block **28** and the coating **40**. The corrosion response provided by the coating **40** will eventually deplete the coating **40**. The thickness can be chosen to

10   provide a coating with a specified useful lifetime. For example, the coating thickness can be chosen based on the rate at which the support **20** is subjected to processes conducted in a processing chamber. The thickness of the coating **40** can also be chosen based on facilitating heat transfer between the support **20** and the substrate **21**. For example, the thickness of the coating **40** can be chosen to provide a specified

15   thermal resistance for the coating **40** based on the thermal resistivity of the silicon-nitride-containing compound. In one version, a suitable thickness of the coating **40** is from about 0.1 micron to about 15 microns.

         The ceramic coating **40** can be applied onto the ceramic block **28** using

20   various methods. For example, the method of forming the coating **40** can comprise physical and chemical vapor deposition methods, a plasma spraying method, twin wire arc spraying method, or other thermal spraying method. One exemplary coating process uses a chemical vapor deposition to deposit the coating **40** onto the block **28**. In the chemical vapor deposition method the portion of the block **28** to be coated is

25   exposed in a process chamber to a deposition gas and heated to deposit a coating **40** on the exposed portion of the block **28**. To deposit a silicon nitride compound, the deposition gas desirably comprises silicon-containing and nitrogen-containing species. For example, the deposition gas can comprise a silicon-containing gas comprising, for example, silane. The deposition gas can also comprise a nitrogen-containing gas,

30   comprising at least one of ammonia, nitrogen and N_2H_4. An inert gas such as argon can also be provided. For example, in one method of fabrication, deposition gas comprising SiH_4 in a volumetric flow rate of about 5 sccm to about 50 sccm and NH_3 in a volumetric flow rate of about 250 sccm to about 10,000 sccm is introduced into the process chamber. The temperature of the block **28** is desirably maintained at a

temperature of about 600°C to about 800°C during the deposition process, and a pressure in the chamber is maintained at about 90 Torr to about 300 Torr.

5   The process of fabricating the block **28** having the coating **40** may optionally include an annealing step to finely tune properties of the coating **40**. In one version, a suitable temperature at which to anneal the block **28** and coating **40** is at about 200°C to about 800°C, and such as about 400°C, for a duration of about 2 hours to about 24 hours. The manufacturing process conditions, including temperature, gas compositions, and energizing levels used during fabrication or annealing of the coating

10   **40**, is monitored and controlled to avoid flaking of the coating **40**. In one method, the annealing step is alternated with the chemical vapor deposition to anneal each fine layer of deposited material. This reduces stresses in the deposited coating and allows deposition of a thicker layer of the sacrificial ceramic coating. The annealing step and chemical vapor deposition step may be alternated a plurality of times. In the chemical

15   vapor deposition process, the deposition gas can also be energized by coupling, for example, RF energy or microwave energy to the deposition gas to form energized silicon and nitrogen-containing species that interact to form the silicon nitride compound coating **40** on the block **28**.

20   The substrate support **20** also comprises a post **30** to hold and position the ceramic block **28** within the processing chamber. The post **30** also provides a convenient way for electrical leads to reach the ceramic block **28** from outside of the chamber. The post **30** comprises a hollow cylinder and may comprise a ceramic or metal. The post **30** can be manufactured using a variety of methods, including casting,

25   machining, and forging. The post **30** can be attached to the ceramic block **28** by mechanical fasteners such as screws and bolts, or by a fabrication process such as sintering, hot pressing, and other methods.

The substrate support **20** further comprises a resistance heater **32** to

30   control heat transfer between the substrate **21** and the support **20**. The resistance heater **32** comprises an electrical resistance that generates heat upon application of a voltage across the resistance. The support **20** also comprises heater leads **34** extending out of the ceramic block **28** to conduct electrical power to the resistance heater **32**. The amount of heat generated is related to the power applied to the

resistance heater **32**. Controlling this power allows fine control of the heat generated by the resistance heater **32**. Controlling the heat generation of the resistance heater **32** allows control of the substrate support temperature and thus control of the heat transfer between the substrate **21** and the support **20**. Ultimately, the temperature of the

5   substrate **21** can be controlled by the power applied to the resistance heater **32**. The resistance heater **32** is desirably capable of maintaining the substrate **21** at temperatures in a range of about 200°C to about 800°C.

In one version, the resistance heater **32** comprises a cylindrical metal wire

10   coiled concentrically to form a spiral from the center to the edge of the block **28**. For example, the resistance heater **32** can be a molybdenum wire. The gauge of the wire is chosen depending upon, among other factors, the amount of heat generated per cross-sectional area of the wire for the chosen material and the desired electrical resistance of the resistance heater **32**. The resistance heater **32** is desirably completely enclosed

15   by the block **28**. The resistance heater **32** can also comprise other physical embodiments, for example alternate materials such as ceramics, or other geometries, such as a wire mesh, multiple coils of wire, or ribbons of material. The heater leads **34** conducting electrical power to the resistance heater **32** can comprise conductors such as molybdenum and nickel.

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The resistance heater **32** can also comprise more than one independently controllable resistive element. The independently controllable resistive elements provide independent heating in different parts of the support **20**. For example, the resistance heater **32** can comprise two independently controllable resistive elements,

25   each having an electrical resistance of between about 2.5 ohms to about 5 ohms, that provide separate heating of two spatially concentric zones on the top surface **22**, an inner zone and an outer zone. An inner resistive element **32a** can be concentrated beneath the inner zone, and an outer resistive element **32b** concentrated beneath the outer zone, and the elements are provided with separate heater leads **34a**, **34b**,

30   respectively, extending down through the block **28** to an external power supply. Depending upon the desired temperature control, the inner and outer resistive elements **32a**, **32b** can receive different power levels from the heater power supply, to heat the inner and outer zones to different temperatures. This provides the ability to compensate for radial temperature variations in the substrate **21**, which can arise from

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the geometry and heat transfer characteristics of the support **20** and the substrate processing chamber.

In another version, there is only one resistive element, having an electrical
5   resistance of about 2.5 ohms to about 5 ohms, to control heat delivered to the entire support. This is advantageous when the substrate process being conducted does not require radial temperature control. In yet another version, there are three separate, independently controllable zones having separately controllable resistive elements: inner, outer, and middle zones. Again in this version, each resistive element beneath
10   each zone has separate heater leads that allow independent control by the heater power supply. This version is advantageous for substrate processes require a high degree of radial temperature control. The substrate support **20** may optionally comprise a plurality of thermocouples to monitor the temperature at various regions of the support **20** and provide a basis for adjusting the power delivered to the
15   independently heated zones.

The substrate support **20** may also optionally comprise a gas energizer electrode **36** that functions as a part of a gas energizer, for example by coupling RF energy to a gas in the process chamber. In one version, the electrode **36** comprises a
20   metallic mesh integrated into the ceramic block **28**. The electrode **36** can comprise a metal such as molybdenum. The electrode **36** is connected to an electrode lead **38** that passes through the post. The electrode lead **38** can electrically connect the electrode **36** to another portion of the chamber or can ground the electrode **36**. The electrode lead **38** can also optionally connect the electrode **36** to an RF or microwave power
25   supply **136** to bias and provide an RF or microwave signal to the electrode **36**. In one version, the electrode lead **38** comprises a nickel-based material. The physical design of the electrode **36** and the electrode lead **38** are conducted according to principles of electromagnetic wave propagation at the relevant frequencies, for instance RF or microwave frequencies.
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The substrate support **20** also comprises holes **44** for lift pins **42**, as illustrated in Figure 1a-c, to lift the substrate **21** from the top surface **22**. The lift pins **42** are positioned at several locations within holes **44** in the ceramic block **28**. For example, in one version, there are four pins **42** positioned equidistant to the center of

the support **20**, at 90° angles from each other. The pins **42** move perpendicular to the plane of the substrate pocket **24**. The pins **42** may be activated by a mechanical system that is part of the chamber in which the substrate support **20** is located. Such a mechanical system can activate the lift pins **42** from the side of the block **28** opposite to the top surface **22**.

The substrate support **20** can be used in substrate processing chambers that deposit Ti-based layers on substrates **21**. One type of chamber to deposit Ti-based layers is a chemical vapor deposition (CVD) chamber such as the one illustrated in Figure 3. The chamber **100** can be a stand-alone chamber or part of a larger processing system that includes multiple chambers. The exemplary substrate processing chamber has enclosing walls **102**, including a top wall **104**, side walls **106**, and a bottom wall **108**. The enclosing walls **102** enclose a process zone **146** in which a substrate **21** is processed. A substrate support **20**, such as that shown in Figure 1A, holds the substrate **21** in the process zone **146**. The support's post **30** is attached to a lift motor **142** that allows the support **20** to move up and down within the chamber **100**. In a low position, the support **20** can align with a port **144** through which the substrate **21** is introduced to the chamber **100** and loaded onto the support **20**. The substrate **21** can be loaded into the chamber **100** by a robot arm (not shown). A wafer lift ring **128** comprising a ring concentric to the support post **30** may also be present. The wafer lift ring **128** rises independently from the post **30**, and rises from below the block **28** into contact with the lift pins **42**. The chamber **100** may also comprise an edge ring **126** to promote separation of the portion of the chamber below the substrate support **20** from the process zone **146**.

A process gas is introduced into the chamber **100** via a process gas inlet **110**. The process gas passes through a showerhead-style gas distributor **116** and then into the process zone **146**. The gas inlet **110** is fed from a process gas valve **112** and a process gas supply **114**. The showerhead **116** uniformly distributes the process gas to the process zone **146**. The showerhead **116** can be a plate with a plurality of holes **118** through which the process gas passes. Alternatively, the showerhead **116** can be integral to the top wall **104**. The gas distributor can also be of a style different from a showerhead. A purge gas can also be introduced into the chamber from a purge gas inlet **130** fed by a purge gas valve **132** and a purge gas supply **134**. Gas is exhausted

from the chamber **100** through a gas outlet **120**. The gas outlet **120** feeds through a exhaust valve **122** into a gas exhaust **124**.

In the version shown in Figure 4, the showerhead **116** also serves as an electrode of a gas energizer. The showerhead is connected to the RF or microwave power supply **136**. The showerhead delivers RF or microwave radiation to the process gas to energize the gas. The enclosing walls **102** and substrate support **20** can be grounded relative to the showerhead electrode **116**. The process chamber **100** also comprises a heater power supply **138** to deliver power to the resistance heater **32**. In one version, the heater power supply **138** is capable of delivering at least about 1000 Watts of power to the resistance heater **32**.

A controller **140** may be used to operate the substrate processing chamber **100**, including controlling the RF power supply **136**, process gas valve **112**, exhaust gas valve **122**, purge gas valve **132**, heater power supply **138**, lift motor **142**, and other components requiring precise control. A suitable controller **140** comprises a computer (not shown) having a central processing unit (CPU), such as a Pentium Processor commercially available from Intel Corporation, Santa Clara, California, that is coupled to a memory, peripheral computer components, and program code to provide instructions to the components of the substrate processing chamber **100**. The controller **140** may further comprise a plurality of interface cards (also not shown) including, for example, analog and digital input and output boards, interface boards, and motor controller boards. The interface between a human operator and the controller **140** can be, for example, via a display and a light pen.

One method to deposit a Ti-based layer, for instance a TiN layer, is to react $TiCl_4$ and NH_3 in a plasma-enhanced CVD chamber **100**. These gases are introduced into the process zone **146** from the process gas inlet **110** through the showerhead **116**. Optionally, there may be separate inlets or process gas valves for each process gas. Additionally, the process gas may comprise carrier gases such as He, H_2, or Ar. An inert purge gas can be flowed between the edge ring **126** and the enclosing walls **102** to prevent process gases from entering into the lower portion of the chamber. The purge gas flow can also be used to finely tune the characteristics of the process zone **146** near the edges of the substrate support **20**.

During the deposition of a Ti-based layer on the substrate **21** in the chamber **100**, Ti-based and other chemicals also deposit on surfaces of the chamber **100**, such as the enclosing walls **102**, edge ring **126**, process gas inlet **110**, and gas outlet **120**. If this extraneous deposition on surfaces other than the substrate **21** is allowed to continue unchecked, the deposits will build until they become unstable, at which point they may begin to flake off the surface on which they've grown. The chamber **100** must be periodically cleaned to remove these extraneous deposits. One method to clean the chamber **100** uses a plasma formed from chlorine gas. Chlorine gas is introduced into the chamber **100** by the process gas inlet **110** and energized using the gas energizer **116**. The energized chlorine gas etches away the Ti-based deposits and cleans the chamber **100**. Unfortunately, the chlorine gas also corrodes the substrate support **20**. The coating **40** according to the present invention, however, provides corrosion response for the support **20** against the energized chlorine gas used to clean Ti-based deposits from chamber surfaces.

The substrate support **20** according to the present invention can also be refurbished to provide an extended useful lifetime. The coating **40** is consumed by the corrosion response it provides to the support **20**. After substantial use, the coating **40** can be refurbished to restore portions of the coating **40** that have been depleted.

The refurbishment process comprises first exposing the ceramic block **28** to a fluorine-containing cleaning medium to remove the residual ceramic coating **40** from the block **28**. In one version, the fluorine-containing cleaning medium comprises an acidic solution. For example, a suitable acidic solution could comprise one or more of HF, HNO_3, NF_4H, H_2O_2, and H_2O. In an exemplary process to remove the residual ceramic coating **40** using an acidic solution, the ceramic block **28** is exposed to a 20% HF solution by weight, for a period of about 10 minutes to about 40 minutes. The ceramic block **28** can be rinsed with a water solution following exposure to the acidic cleaning solution.

In another version, the cleaning medium comprises an energized fluorine-containing gas. For example, the ceramic block **28** can be placed in a processing chamber adapted to implement an etching process using an energized fluorine-

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containing gas. In one version, the process gas to be energized could comprise NF_3, CF_4, C_2F_6 or ClF_3. In an exemplary version of cleaning the residual coating **40** using an energized fluorine-containing gas, the ceramic block **28** is placed in the processing chamber, NF_3 is introduced into the chamber and energized, and the etching process is

5   conducted at about 200°C to about 500°C for about 0.5 hours to about 3.0 hours.

The refurbishment method further comprises placing the cleaned ceramic block **28** in a deposition chamber and depositing the ceramic coating **40** on at least a portion of the cleaned ceramic block **28**. This deposition can use the same methods

10   and apparatuses discussed above in regards to manufacturing the coating **40** on the ceramic block **28**. For example, the deposition can comprise heating the cleaned ceramic block **28** and exposing the heated ceramic block **28** to a process gas comprising silicon and nitrogen species. In one version, the clean ceramic block **28** is heated to a temperature of about 600°C to about 800°C, and the process gas

15   comprises silane, ammonia, and nitrogen. The refurbishment process may further comprise annealing the block **28**, as discussed above in regards to the method of manufacturing the coating **40** on the block **28**. For example, the annealing step may comprise heating the block **28** to a temperature of about 200°C to about 800°C for a duration of about 2 hours to about 24 hours.

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Although the present invention has been described in considerable detail with regard to the preferred versions thereof, other versions are possible. For example, the ceramic material of the block **28** can comprise ceramic materials other than those mentioned. Additionally, relative terms such as bottom, top, up, and down are in some

25   instances interchangeable and have been used merely to describe embodiments of the invention. Therefore, the appended claims should not be limited to the preferred versions and relative terms contained herein.